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DEVELOPMENTS IN CONCENTRATED FERTILIZERS

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A radio talk by Mr. C. H. Kunsman, division of physics and physical chemistry, Bureau of Chemistry and Soils, delivered through Station WRC and 39 other stations associated with the National Broadcasting Company, January 14, 1931.

It is no exaggeration to say that the fixation of nitrogen from the air has been one of the most exciting and important developments within the last ten years, ranking in importance with the development of the automobile and the radio. From some angles it may even be thought of as more important, since the maintenance of the productivity of the soil, which is greatly aided by the application of fertilizers, is the basis of our existence. The increase in the world's population can be sustained only by an increased food supply. To this end the use of fertilizer is very effective in bringing about larger and better crops from less acreage, with a resulting decrease in both hours of labor and man power.

The increased demand for fertilizers within the last five years has changed the entire picture of the fertilizer industry. The new nitrogen and fertilizer industry demands new methods of research. For this purpose there is now available in the Department of Agriculture a work shop, the Fertilizer and Fixed Nitrogen Laboratories of the Bureau of Chemistry and Soils, in which fascinating studies are being carried on. These studies range from those on the electrical properties of catalysts, in tubes similar to your radio tubes, which mysteriously cause the normally inactive nitrogen of the air we breathe to unite with other substances, to an investigation of how the bacteria in the soil fix over 90% of the nitrogen used in plant growth, and research on a blast furnace that uses 5 tons of coke or coal a day for the production of phosphoric acid and potash.

I wish to give you briefly a picture in simple terms of how the three main substances, nitrogen, phosphoric acid, and potash may be obtained and made into a concentrated fertilizer.

The latest development in nitrogen fixation is the direct formation of ammonia from nitrogen and hydrogen. The air is four-fifths nitrogen and one-fifth oxygen. For the fixation of this nitrogen the oxygen is first removed either by physical or by chemical means, and hydrogen is obtained by blowing steam over coke, and by other methods, such as passing electricity through water. The nitrogen and hydrogen are now mixed in proper proportions, compressed at pressures of one hundred to one thousand times the pressure exerted by our atmosphere, heated to a high temperature, and passed over a catalyst, which causes the nitrogen to combine with the hydrogen to form ammonia. This ammonia gas is then condensed to a liquid by decreasing the temperature and is drawn off into tank cars or storage tanks. When dissolved in water it forms the ammonia cleaning solution used about the home. For fertilizer purposes the ammonia is used in this country largely in two ways: (1) It is mixed with air at a high temperature and passed over a catalyst, whereupon the nitrogen in the ammonia combines with the oxygen of the air to form nitrogen oxides, similar to those formed by lightening in thunderstorms. These oxides are taken up by an aqueous alkali solution. On

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neutralizing with soda ash and drying a white salt results. This is nitrate of soda, similar to Chilean saltpeter. During the last two years much of the output of one of the large nitrogen fixation plants has been synthetic nitrate of soda for fertilizer purposes. (2) The ammonia is used directly in fertilizer mixtures containing superphosphate. Ammonia produced at the various plants is going into the fertilizer trade in this form. Ammonia is the cheapest form of fixed nitrogen; therefore, when it is poured directly on the superphosphate mixture you are getting one of the cheapest and most satisfactory forms of nitrogen in the fertilizer mixture. Since the amount of air nitrogen is unlimited and we now have fixation plants in the United States with a capacity of two hundred thousand tons of nitrogen annually, or about one-half of our total consumption in fertilizers, we need not look for a shortage in fixed nitrogen.

The second plant food is obtained from phosphoric acid. The natural phosphate rocks, mainly from Florida and Tennessee, are digested with the cheapest acid, namely, sulphuric acid, giving phosphoric acid. This acid when neutralized by the addition of ammonia gives ammonium phosphate, a crystalline product. These phosphate deposits are very extensive and will be sufficient for our needs for many years.

The third plant food is potash. The potash produced in this country, amounting to about one-fifth of our consumption, is obtained by the chemical treatment of the brines of Searles Lake, California. In this case it is obtained with the production of borax, another cleaning material often found about the home. The remainder of the potash, or four-fifths of our need, is obtained from Europe, where the potash is mined and treated for the extraction of impurities.

The blast furnace previously referred to offers promise of considerably cheaper phosphoric acid and potash. This is a modified form of the blast furnace which is used for the production of iron. The phosphate or potash bearing rocks, or both, are mixed with coal or coke and brought to a high temperature in the blast furnace. The phosphorus and potassium leave the rock, vaporize, and go to the top of the furnace, where they are drawn off and collected, while the slag or residue is drawn off from the bottom of the furnace in a molten form. By this method it is believed that this country's abundant supply of raw materials, phosphate and potash-bearing rocks, may be better utilized as a cheaper source of these materials in the future. In the blast furnace the price of coal or coke is the main item. Since coal is still our cheapest and most extensive source of heat or energy it is very natural that for cheapening the constituents of fertilizer we look further to the utilization of coal in the production of fertilizers.

Now, having these materials, let me give you an example of how simple and easy it is to produce a concentrated fertilizer from the cheapest form of fertilizer materials now available. Nitrogen in the form of ammonia - 80% plant food - is sprayed into a mixture of muriate of potash - 50% plant food - and superphosphate - 18 to 20% plant food. Other materials may be incorporated in the mixture as desired. The mixing takes place in a rotating drum with the development of considerable heat. When the mixture is discharged from the drum the hot mass loses water by evaporation, leaving a dry, granular product with properties well suited for fertilizer use.

The fertilizer bill of the farmers of the United States is about $250,000,000 annually for 8,000,000 tons of fertilizer. Among the advantages of a concentrated fertilizer are lower cost of transportation and less cost for bags. These two items alone now amount to about $32,000,000. The average plant food content of fertilizers has increased from about 15% in 1920, to over 18% in 1930. With greater increase in plant food concentration, through increased use of the high grade materials available, further reductions in cost may be expected.

Realizing that there is a limit to the reduction of the cost of fertilizers, we are also actively engaged in work toward increasing the efficiency of fertilizers; that is, to obtain the maximum crop yields from your dollars invested in fertilizers. The efficiency of fertilizers can be increased by,

1. Increasing the uniformity with which fertilizers are distributed. Within the last two years cooperative work between the Department of Agriculture and State Experiment Stations has shown that a saving of at least 10% of the fertilizer can be realized by a uniform distribution in the field.

(2) Proper placement of the fertilizer in the soil with respect to the seed. When applied with cotton seed on sandy soils a good placement of the fertilizer is about two inches to the side and two inches below the level of the seed. This resulted in a 20% increase in the cotton yield over that where the fertilizer was applied in the usual way. These tests were made both with fertilizers of the average normal strength and those of twice this plant food content with equal success. Fertilizer mixtures of the latter concentration are now available on the market.

(3) Improving the quality of the fertilizer. Elements other than the big three, nitrogen, phosphorus and potassium, for example, calcium in the form of lime, and magnesium are also very important. Of these a relatively small amount, 10 to 40 pounds per acre, when added to soils deficient in these elements gives a very good increase in yields.

In conclusion, let me again state that our fertilizer studies consist in how best to convert nitrogen, phosphoric acid, potash, and other materials, into fertilizers and in making them of greater benefit to the farmers in the following ways: By making their cost as low as possible; by increasing the plant food content of the mixtures; by improving the drillability of fertilizer mixtures, and by developing more efficient methods of applying them to crops.